Metrocycle 2.0: Enhancing a Road Safety Education App for Motorcycle and Bicycle Riders

Vincent Angelo Dispo[1], Sean Ken Cedric Legara[1], Paul Jaren Perez[1]*, Richelle Ann Juayong[1], Francis George Cabarle[1], and Sandy Mae Gaspay[2]

[1] Department of Computer Science, University of the Philippines Diliman, Quezon City, Philippines,
{vdispo, sglegara, *paperez2, rbjuayong, fccabarle}@.up.edu.ph,
[2] National Center of Transportation Studies, University of the Philippines Diliman, Quezon City, Philippines
sagaspay1@up.edu.ph,

Abstract. Metrocycle is a browser-based road safety education game developed to reinforce proper driving behaviors among Filipino motorcycle and bicycle riders through a gamified education approach. However, like any application, many of its aspects, such as user interface and user experience (UI/UX), accessibility, and educational scope, can be further developed to realize its full potential. This paper presents the features implemented to address these areas and create an improved version of the game, aptly called Metrocycle 2.0. The effectiveness of these improvements was evaluated through various validation tests among inexperienced riders, experienced drivers, and domain experts. One of these tests, a comparative software evaluation of the original (1.0, hereafter) and 2.0 using the Game-based Learning Evaluation Model (GEM), showed a positive reception to the changes made. Six (6) design and learning indicators earned significant differences between the two versions: action language, feedback, game world, controls, self-efficacy, and motivation. These positive results highlighted the value of improving these three areas to create an effective educational game.

Keywords: road safety education, gamified education, user interface and user experience (UI/UX), accessibility, educational scope

1 Introduction

Recent years saw the rise of motorcycles and bicycles as modes of transportation and sources of livelihood in the Philippines. According to the 2023 report of the Philippine Land Transportation Office (LTO), motorcycles and other non-conventional vehicles make up 6,826,729 or about 58% of the total number of registered vehicles in the country [1]. In addition, the Metropolitan Manila Development Authority (MMDA) recorded 36,486 motorcycle-related accidents in Metro Manila alone, 271 of which were considered fatal [2]. Although there are

J. Caro et al. (eds.), *Proceedings of the Workshop on Computation: Theory and Practice (WCTP 2025)*, Atlantis Highlights in Computer Sciences 24,
https://doi.org/10.2991/978-94-6239-638-8_9

systems to ensure that riders are competently equipped for the road, most of these are just one-time seminars and workshops. Respondents to a 2021 study expressed the desire for more training that is more easily accessible than existing physical options [3]. Hence, more innovative road safety education efforts are needed more than ever, as the lack of one has evidently put riders at great risk and danger [4].

In response to this need, multiple road safety education software have been developed. Honda's Motorcycle Riding Simulator employs realistic traffic scenario simulations using a motorcycle-based setup (see Figure 1) [5]. Safety Driving Simulator: Motorbike integrates safety gear education through avatar customization (see Figure 2) [6]. Lakbay features a pre-driving checklist compliance module patterned from the Filipino mnemonic BLOWBAGETS, which stands for Battery-Lights-Oil-Water-Brake-Air-Gas-Engine-Tire-Self (see Figure 3) [7]. However, these applications suffer from limited accessibility due to specialized equipment, constrained platforms, and lacking relevance for Filipino riders.

Fig. 1. Honda's Motorcycle Riding Simulator setup

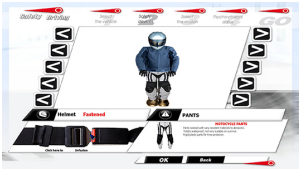

Fig. 2. Customization in Safety Driving: Motorbike

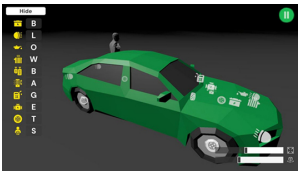

Fig. 3. BLOWBAGETS module in Lakbay

These critical gaps motivated the development of Metrocycle, a browser-based game that simulates Philippine traffic scenarios [8]. Unlike conventional approaches, the game aims to expose Filipino users to real-world hazards contextualized in the country, serving as a preparatory tool and supplemental learning resource. Although it demonstrates great potential, feedback suggested further developments in its UI/UX design, accessibility, and educational scope.

This study addressed these points of the game through the following: improve its UI/UX design by reworking certain mechanics and implementing new features, expand its accessibility by porting it to Android and adding a Filipino language option, and extend its educational scope by including more complex scenarios and introducing a riding preparation mode. Through these targeted steps, the study explored how an improved Metrocycle can lead to better engagement, higher learning, and safer behaviors among Filipino riders.

This paper is structured as follows. Section 2 discusses the original version of the game, 1.0, and its current features and challenges. Section 3 presents the improvements and changes made for 2.0. Section 4 discusses the validation tests conducted and the feedback collected. Lastly, Section 5 synthesizes the contributions of this study and offers directions for future work.

2 Metrocycle 1.0

Motivated by the increasing use of motorcycles and bicycles in the country, Metrocycle 1.0 was developed to be an effective and accessible tool to learn contextualized safe riding practices in the Philippine setting [8]. The game is available to play via a browser through https://jmbatrina.itch.io/metrocycle.

2.1 Features

1.0 features two (2) selectable vehicles, a motorcycle and a bicycle (see Figure 4), each with three (3) gameplay modes: tutorial, basic scenarios, and advanced scenarios (see Figure 5). The tutorial mode walks through the controls and mechanics of the game. Through a simple map, it introduces the keyboard scheme used to maneuver, as well as fundamental actions like head checks and blinkers.

Fig. 4. Vehicle selections

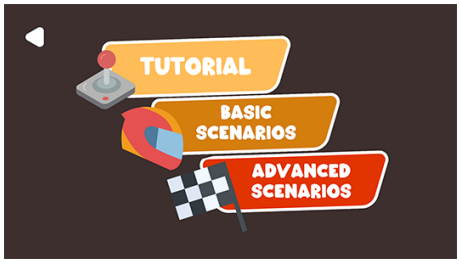

Fig. 5. Gameplay modes

The basic scenarios demonstrate four (4) common traffic rules: speed limits on a straight road, use of a U-turn, procedures at an intersection, and lane change in a multilane (see Figure 6). On the other hand, the advanced scenarios simulate two (2) major roads in the Philippines: Commonwealth and EDSA (see Figure 7). A set of instructions must be performed to complete each scenario.

Fig. 6. Basic scenario set in an intersection

Fig. 7. Advanced scenario set in EDSA

Most importantly, all gameplay modes acknowledge correct and wrong actions. Typically, a correct action either continues or finishes the level, while a wrong action prompts a warning or resets the scenario (see Figure 8).

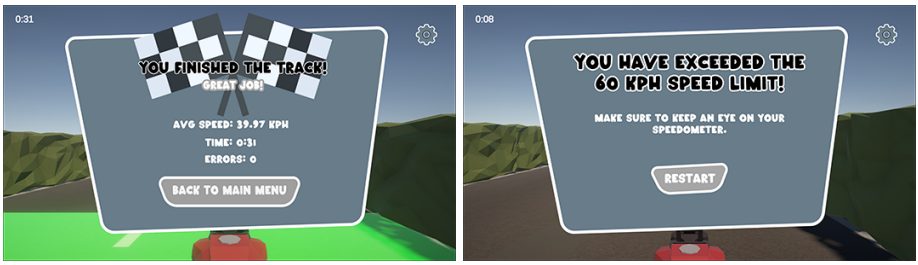

Fig. 8. Finish prompt *(left)* and reset prompt *(right)* in the straight road scenario

The results of the validation tests for 1.0 showed that it has the potential to improve the learning and reinforcement of road rules and safety practices while being more engaging and motivating than traditional programs such as seminars and manuals [8].

2.2 Challenges

Although the feedback on 1.0 was positive, a list of potential points of improvement for the game was also derived, especially from the results of the software evaluation. This utilized the Game-based Learning Evaluation Model (GEM), which quantitatively measures certain categorical indicators that enhance the educational value of a serious game [9]. These indicators include action language, feedback, rules and goals, game world, controls, self-efficacy, and motivation. Table 1 provides a brief description of each indicator and the score each received for 1.0. In addition to these quantitative scores, the testers also provided written feedback that served to guide the thematic analysis of each indicator.

After reviewing these, the following three (3) aspects of 1.0 were considered challenges.

UI/UX. 1.0, while generally user-friendly and easy to use, was recommended to further develop its UI/UX design. In particular, three (3) were identified as areas for development: controls, progress indicators, and feedback mechanisms.

1. **Controls.** 1.0 utilizes a keyboard as its sole controller (see Figure 9). However, the control indicator scored the lowest in the software evaluation, with its thematic analysis suggesting a steep learning curve. In addition, the side mirrors were noted to be quite small, making it difficult to utilize (see Figure 7). Finally, the testers found the mechanics for accelerating and turning slightly hard to control as both are simply binary. The head check was also deemed disorienting due to its speed.

Table 1. GEM indicators and their descriptions with 1.0 scores

Indicator	Description	Score (out of 5)
Action Language	effectiveness of instructions	4.17
Challenge	difficulty level of objectives	4.09
Controls	intuitiveness of controls	3.82
Feedback	quality of feedback	4.04
Rules and Goals	instructions of gameplay	4.20
Game World	immersion of environment	3.84
Motivation	interest in continuing	4.16
Self-efficacy	belief in self's performance	3.65

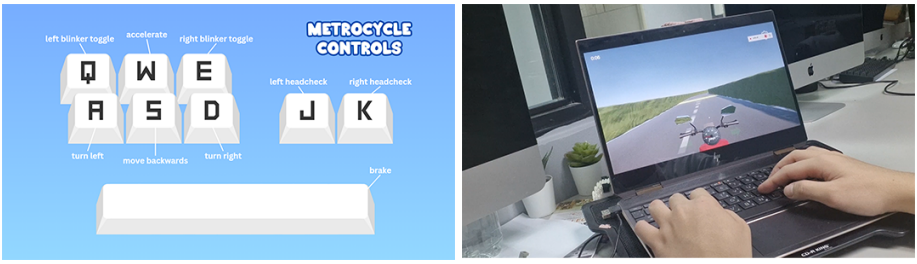

Fig. 9. Keyboard control scheme of 1.0

2. **Progress indicators.** The testers also noted confusion about the current goal of the scenario, as the instruction only appears in a single pop-up, which will not reappear once closed. Furthermore, they could not gauge the number of tasks remaining as there are no indicators of the total number (see Figure 10). These were reflected in the action language indicator.

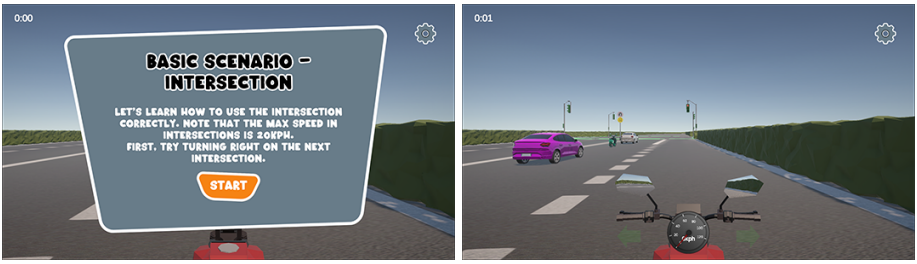

Fig. 10. Pop-up prompt *(left)* and screen after closing the prompt *(right)*

3. **Feedback mechanisms.** The feedback indicator found that some mechanisms, such as the error reset, to be improvable. Committing any type of mistake in an advanced scenario, regardless of its severity, warrants a com-

plete reset to the start, which the testers found frustrating (see Figure 11). In addition, it was also recommended to refresh the presentation of player statistics in the main menu (see Figure 12).

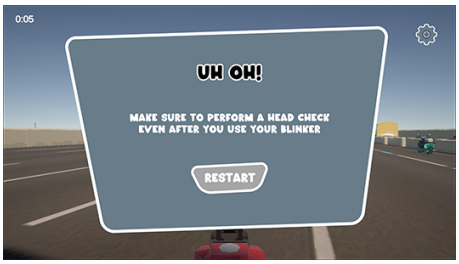

Fig. 11. Full reset for failing a head check

Fig. 12. Player stats page

Accessibility. 1.0 was developed with accessibility in mind. However, there are certain improvements in this aspect that can still be made: Android port and Filipino integration.

1. **Android port.** Although 1.0 is available for any device that can operate a browser, it still requires a physical keyboard. The control indicator recommended looking for other devices that can be more conducive to the game. This setup also does not take advantage of the market report on how Android represents the majority of smartphones used in the Philippines [10].
2. **Filipino integration.** The thematic analysis of the action language indicator emphasized the need for a Filipino version of the game. Its current English-only environment limits its accessibility to its target demographic of Filipinos.

Educational Scope. As 1.0 is just new, it is understandable that more educational modules can be added. The tests mainly pointed to an increased complexity, especially for more experienced riders.

1. **Increased complexity.** Experienced riders expressed a desire for more complexity in the scenarios, supported by the challenge and motivation indicators. A recommendation was to include conditions that may affect visibility. Furthermore, it is also necessary to expand the part of the scope that is more relevant to inexperienced riders. This can be achieved by adding a riding preparation mode similar to that in Lakbay (see Figure 3).

3 Metrocycle 2.0

To address the challenges found in 1.0, numerous improvements were implemented for 2.0. These were mainly guided by the recommendations for 1.0,

as well as five (5) psychological design principles: affordances, signifiers, constraints, mapping, and feedback [11]. The game is available for download via https://github.com/VDispo/Metrocycle-2.0/releases/tag/build15c.

UI/UX. A combination of new and improved features focused on UI/UX.

1. **Controls.** The principles of affordances and mapping were used to design the new control scheme. These principles emphasize the importance of making the design feel natural and intuitive. Therefore, the new controls for 2.0 leverage the capabilities of Android devices. Most are now clickable buttons, toggles, and sliders, with the exception of turning, which uses the phone accelerometer sensor (see Figure 13 and Table 2).

Table 2. Differences of controls in 1.0 and 2.0

Mechanic	1.0	2.0
accelerating	W	spring-loaded slider
braking	S or spacebar	buttons
turning	A (left) and D (right)	accelerometer
blinker	Q (left) and E (right)	toggle slider
head checking	J (left) and K (left)	buttons

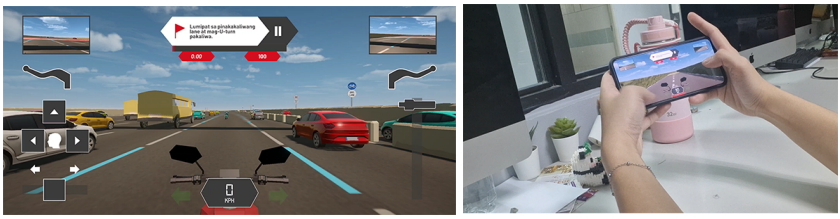

Fig. 13. Mobile control scheme of 2.0

The side mirrors are also now part of the screen instead of just in the vehicle itself (see Figure 13). Finally, the mechanics for accelerating and turning have been changed from binary to variable, making them easier to control. The speed of the head check was also reduced.

2. **Progress indicators.** A persistent banner was added to inform the player of their current goal, as well as a progress bar below it to gauge their progress (see Figure 14). Signifiers served as the guiding principle in these features as clear and consistent communication is a must in educational games.

Fig. 14. Persistent objective banner and progress bar

3. **Feedback mechanism.** The constraints principle states that the limitations must not negatively affect the enjoyment of the game. Hence, the reset mechanism now relies on a scoring system. Beginning with an initial value of 100, the score will either go up or down depending on the correctness of the action performed (see Figure 15). Reaching zero (0) will prompt a reset.

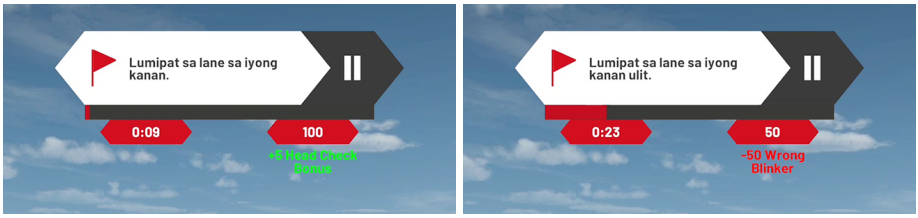

Fig. 15. Positive *(left)* and negative *(right)* score

The player statistics page was also updated to include the best records for each vehicle. The exact errors committed per gameplay is also now recorded to help guide the player in their next try (see Figure 16). This was a result of the feedback principle, which encourages meaningful but not overbearing responses.

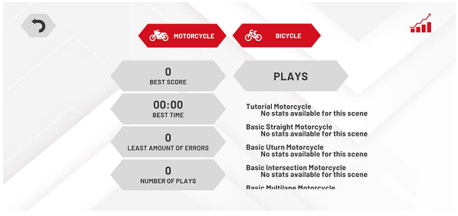

Fig. 16. Player stats page in 2.0

Accessibility. New features were implemented to address the accessibility challenges of 1.0.

1. **Android port.** 2.0 has turned 1.0 from a browser game into an Android application. All features of 1.0 were adapted to a new mobile environment (see Figure 13).
2. **Filipino integration.** The entire game was given a Filipino translation. In addition, a centralized language selection system was implemented to allow easier new language integration (see Figure 17).

Fig. 17. Language selection menu *(left)* and prompt in Filipino *(right)*

Educational Scope. The existing gameplay modes were further expanded to include more important lessons.

1. **Increased complexity.** Conditions that simulate poor visibility were created. Evening, rain, fog, and any combination can be applied in basic and advanced scenarios (see Figure 18).
   A riding preparation mode based on BLOWBAGETS was also added to the start of each scenario. The players are tasked with thoroughly checking the condition of their vehicle (see Figure 19).
   Through a simple avatar customization, they must also ensure that their character is wearing the correct safety gear. They can only proceed to the scenario once they complete this mode correctly (see Figure 20).

4 Testing and Results

To assess the effectiveness of the improvements made, a series of validation tests was performed. More specifically, the three (3) aspects of 1.0 and 2.0 were compared using specific metrics, all with the goal of 2.0 generating a statistically significantly higher result measured using the p-value of the Mann-Whitney U test (see Table 3). Obtaining a p-value less than or equal to 0.05 suggests that the results between the two are statistically significant and that the difference is not just due to random chance.

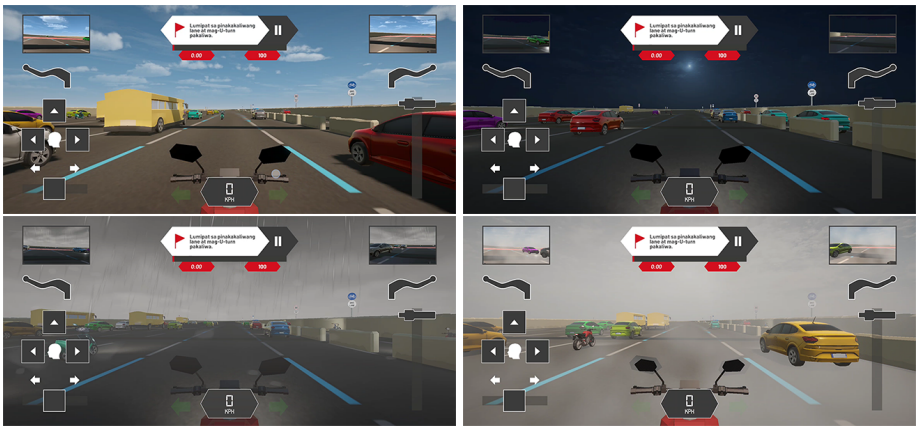

Fig. 18. Commonwealth scenario in normal *(top left)*, evening *(top right)*, rain *(bottom left)*, and fog mode *(bottom right)*

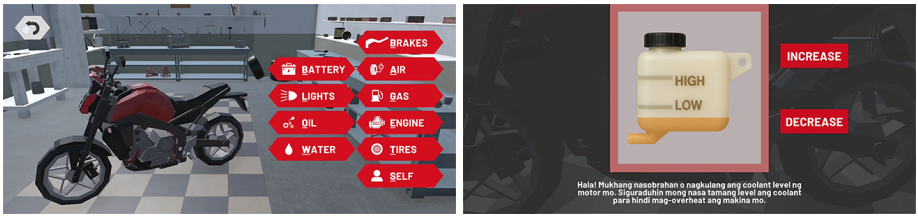

Fig. 19. BLOWBAGETS minigame overview *(left)* and for water *(right)*

Fig. 20. Avatar customization *(left)* and when done correctly *(right)*

4.1 Population

Three (3) groups were organized: inexperienced riders, experienced riders, and domain experts.

1. **Inexperienced riders.** These consisted of 20 people with little to no riding experience divided into two (2) groups: control and experimental. Each group took a 40-item pre-test based on the LTO Mock Exam for 15 minutes [12]. Afterwards, they were given 15 minutes to play a version of the game (1.0 for control; 2.0 for experimental). This was followed by another

Table 3. Metrics used to compare 1.0 and 2.0

Aspect	**GEM** ($p \leq 0.05$)	**Other**
Controls	Control	–
	Rules and Goals	–
Progress indicators	Action Language	–
	Feedback	–
Feedback mechanisms	Challenge	–
	Feedback	–
	Self-efficacy	–
Android port	Control	–
Filipino integration	Action Language	–
Increased complexity	Challenge	
	Rules and Goals	Empirical Pretest/Post-test
	Game World	($p \leq 0.05$)
	Motivation	

15-minute, 40-item post-test. Then, they evaluated the version they tested using a questionnaire based on the GEM. Lastly, they played and evaluated the other version of the game (2.0 for control; 1.0 for experimental).

2. **Experienced riders.** These consisted of five (5) people who had at least one (1) year of riding experience. Similarly, they were made to play and evaluate both versions of the game for 15 minutes each. In addition, semi-structured individual interviews were conducted.
3. **Domain experts.** These consisted of three (3) people who have specialized knowledge in riding motorcycles and bicycles. They were presented with both versions of the game, primarily highlighting the differences, and were asked for feedback through a semi-structured interview.

Unfortunately, due to constraints in time and resources, the researchers opted to use convenience sampling to collect the participants.

4.2 Game-based Learning Evaluation Model (GEM) Software Evaluation

Like in the original study, the Game-based Learning Evaluation Model (GEM) was used to evaluate both versions of Metrocycle through a 5-point Likert scale questionnaire given to the testers (see Table 5).

The results show statistical improvements in all GEM indicators, with the exception of the challenge ($p = 0.23$) and the rules and goals ($p = 0.055$) indicators. Although the pain points in the original version were successfully addressed, the thematic analysis of these two indicators showed the need to build on a few of them further. The participants wished for a less punishing reset system for challenge and better calibrated AI vehicles for rules and goals.

Table 4. Differences of GEM results in 1.0 and 2.0

Indicator	1.0	2.0	p (≤ 0.05)
Action Language	4.17	4.74	**0.0015**
Challenge	4.09	4.36	0.23014
Controls	3.82	4.39	**0.00714**
Feedback	4.04	4.72	**0.00194**
Rules and Goals	4.20	4.73	0.05486
Game World	3.84	4.47	**0.00278**
Motivation	4.16	4.63	**0.03318**
Self-efficacy	3.65	4.42	**0.0005**

As for the other indicators, textual feedback showed that participants generally praised the new features, specifically BLOWBAGETS for self-efficacy, Filipino integration for action language, mobile control scheme for controls, and scoring system for feedback.

In general, the comprehensive GEM analysis indicated that while both versions met basic educational and interactive requirements, 2.0 consistently outperformed 1.0 in critical areas such as clarity, immersive experience, responsive controls, improved self-efficacy, and motivational design. These findings highlight the strengths of the improvements made in delivering effective educational content, enhancing user engagement, and fostering sustained motivation and learning outcomes.

4.3 Empirical Pretest and Post-test (Inexperienced Riders)

The inexperienced riders were tasked with answering a pretest and a post-test to gauge their learning before and after playing a version of the game (1.0 for control and 2.0 for experimental). The group consisted of 20 college students aged 20 to 25 years, none of whom had prior experience driving a motorcycle. However, half reported having taken and passed the driver's license exam.

The control group exhibited an average pretest score of 31.2 and an average post-test score of 31.9, indicating a mean improvement of 0.7. The experimental group had a slightly lower pretest average of 29.5 and improved marginally to an average post-test score of 30.5 (SD = 2.51), representing an average increase of 1.0. These yielded a p-value of 0.76418, revealing a non-statistically significant difference in improvement scores between them. This null result could be attributed to several factors, such as the limited playtime of 15 minutes or the small sample size of 10 per group. Furthermore, the questions might not have accurately or comprehensively reflected the in-game educational material, and the types of cognitive or motor tasks engaged in gameplay may not have translated effectively into the quiz-based evaluation format.

4.4 Semi-structured Interviews (Experienced Riders)

The experienced riders were asked a set of questions about their experience with both versions of the game. The riders had individual driving experiences ranging from 1 to 11 years. Their knowledge of road rules and safety practices was acquired through formal driving schools, informal instructions from family members, seminars, workshops, and online platforms.

The new version of Metrocycle was highly favored, notably scoring higher in educational scope (4 out of 5), accessibility (4 out of 5), and UI/UX design (5 out of 5). The participants specifically appreciated the new features, highlighting the BLOWBAGETS checklist, realistic and intuitive controls, and the option to use the Filipino language. They also emphasized its immersive and practical aspects, noting its suitability for users unfamiliar with motorcycle operations. Lastly, they recommended adding realistic road scenarios, including pedestrian and animal crossings, differentiated handling for manual and automatic motorcycles, and a comprehensive almanac or dictionary of road signs.

4.5 Domain Expert Validation

To ensure the realism and effectiveness of the improvements made, the game was evaluated by domain experts from the UP National Center for Transportation Studies (UP NCTS). Domain expert validation focused on content accuracy, scenario realism, educational value, and system usability.

The experts commended specific features for their educational efficacy, particularly praising the integration of the BLOWBAGETS checklist and the detailed elaboration of common riding mistakes, both contributing significantly to user understanding and learning. In addition, they advised establishing a clear pass/fail score threshold to better clarify performance standards for users, alongside implementing an online leaderboard to encourage healthy competition and enhance motivation. Furthermore, it was recommended to create a comprehensive "About" page to provide users with contextual understanding about the goals and framework of the game.

4.6 Summative Results

Most of the metric goals for 2.0 were achieved (see Table 5). As evidenced by the results, significant gains were made in UI/UX, particularly in terms of control, action language, feedback, and self-efficacy. However, the same cannot be said about challenge and rules and goals. For accessibility, both improvements were successful in meeting their respective goals. Regarding educational scope, improvements were observed in game world and motivation, but not for challenge, rules and goals, as well as the empirical pretest/post-test, strongly suggesting that these areas require further development.

Table 5. Metric goals achieved and not achieved by 2.0

Aspect	Metric	Achieved?
Controls	Control	**Yes** ($p = 0.00714$)
	Rules and Goals	No ($p = 0.05486$)
Progress indicators	Action Language	**Yes** ($p = 0.0015$)
	Feedback	**Yes** ($p = 0.00194$)
Feedback mechanisms	Challenge	No ($p = 0.23014$)
	Feedback	**Yes** ($p = 0.00194$)
	Self-efficacy	**Yes** ($p = 0.0005$)
Android port	Control	**Yes** ($p = 0.00714$)
Filipino integration	Action Language	**Yes** ($p = 0.0015$)
Increased complexity	Challenge	No ($p = 0.23014$)
	Rules and Goals	No ($p = 0.05486$)
	Game World	**Yes** ($p = 0.00278$)
	Motivation	**Yes** ($p = 0.03318$)
	Empirical Pretest/Post-test	No ($p = 0.76418$)

5 Conclusion and Recommendations

The improvements made for Metrocycle 2.0 highlighted the importance of UI/UX design, accessibility, and educational scope in creating effective road safety education games. However, like 1.0, 2.0 raised points for potential improvement.

1. **Build upon special scenarios.** Although they add to the immersion, the special scenarios (see Figure 18) do not pose any new challenge. This can be remedied by adding condition-specific events such as skidding in the rain.
2. **Add real-life obstacles.** The environment in the scenarios are limited to only other vehicles (see Figure 13). To deepen learning, it is recommended to incorporate obstacles such as pedestrians, road bumps, and traffic enforcers.
3. **Improve AI vehicles.** Some AI vehicles fail to follow the mechanics of the road, disrupting player experience and immersion (see Subsection 4.2). It would be worthwhile to revisit their programming and calibration.
4. **Introduce graphical prompts.** The new text prompts, although shorter than those of the original, are still exhausting to read, especially consecutively (see Figure 17). Switching these to more visual-based instructions may be more effective and less tedious for users.
5. **Expand vehicle customization.** Both vehicles, particularly the motorcycle, have only one model (see Figure 19). They can benefit from other builds such as manual and automatic for motorcycles.
6. **Gather randomized participants and increase the sample size.** The study had a small sample size of only 20 participants (see Subsection 4.1). A larger population will most likely provide more insightful results.
7. **Implement stronger learning validation methods.** Future works could benefit from having more robust and objective methods for validating learning outcomes and skill transfer capabilities.

6 Acknowledgment

R.A. Juayong acknowledges Robert Cheng, the URATEX Professional Chair in Engineering. F.G. Cabarle thanks the Scientific Productivity System of the University of the Philippines (2021–2023) for their support.

References

1. Philippine Land Transportation Office (LTO): Annual Report 2023 (2023). https://lto.gov.ph/wp-content/uploads/2023/11/Annual_Reports-2023.pdf
2. Metropolitan Manila Development Authority (MMDA): Annual Report 2023 (2023). https://mmda.gov.ph/images/Home/FOI/MMARAS/MMARAS_Annual_Report_2023.pdf
3. Ningal, J.B., Onos, C.F.: Traffic Education, Publicity and Training in Road Safety: Basis for Road Safety and Accident Awareness Program (2021). https://www.academia.edu/64134146/Traffic_Education_Publicity_and_Training_in_Road_Safety_Basis_for_Road_Safety_and_Accident_Awareness_Program
4. Kamid, S., Lantonero, G.S., Gaspay, S.M., Brides, C.: Insights into Motorcycle Riders' Training, Behaviors, and Road Safety Practices: A Survey Study among Motorcycle Enthusiasts. In: Proceedings of the 30th Annual Conference of TSSP (2024). https://ncts.upd.edu.ph/tssp/wp-content/uploads/2024/09/TSSP2024-23-Revised-Paper.pdf
5. Honda: Honda Introduces Easy-To-Use PC-based Motorcycle Safety Training Device: Riding Trainer (2005). https://global.honda/en/newsroom/news/2005/c050930b-eng.html
6. United Independent Entertainment: Safety Driving Simulator: Motorbike (2016). https://store.steampowered.com/app/450600/Safety_Driving_Simulator_Motorbike/
7. Amolat, N.I.: Lakbay: A Three-Dimensional Game About Driving Fundamentals and Road Courtesy and Safety of Gear-1 Driving School (2022). https://doi.org/10.6084/m9.figshare.20424726.v2
8. Batrina, J.P., Gonzaga, C., Riña, B.J., Juayong, R.A., Gaspay, S.M., Cabarle, F.G.: Metrocycle: Designing a Browser-Based Road Safety Education App for Motorcycle and Bicycle Riders in Metro Manila, Philippines. In: Novel and Intelligent Digital Systems: Proceedings of the 4th International Conference (NiDS 2024), pp.201-212 (2024). https://doi.org/10.1007/978-3-031-73344-4_16
9. Oprins, E., van de Boer-Visschedijk, G., Roozeboom, M., Dankbaar, M., Trooster, W., Schuit, S.: The game-based learning evaluation model (GEM): Measuring the effectiveness of serious games using a standardised method. In: International Journal of Technology Enhanced Learning, pp.326-345 (2015). http://doi.org/10.1504/IJTEL.2015.074189
10. Internation Data Corporation (IDC): IDC: Philippine Smartphone Market Recovers in 2023 After Two Years of Decline (2024). https://idc.com/getdoc.jsp?containerId=prAP51895024
11. Norman, D.: The Design of Everyday Things. MIT Press (2013)
12. Philippine Land Transportation Office (LTO). LTO Mock Exam. https://lto-reviewer.com/lto-exam-reviewer.